Sunflower and naked barley seed huller using a kitchen sink garbage disposer

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This small centrifugal huller is adapted from centrifugal impact hullers (1, 2). It uses a vertical axis motor, grinding ring and discharge system from a kitchen sink garbage disposer (Figure 1). A removable impeller blade replaces the hammers and a smaller diameter, removable turntable replaces the original turntable. The ¾ horsepower garbage disposer huller handles small volume, has no speed control and is not for continuous operation.

To convert the garbage disposer into a centrifugal huller:

- Remove the insulated jacket, sink mounting rings, hopper, gasket and grinding ring from the garbage disposer motor housing (3) (Figure 2).
- Remove the turntable assembly from the motor shaft (Figure 3).
- Grind off the rivets on turntable assembly and separate the cross-arm (Figure 4).
- Tap threads in the rivet holes of the cross-arm (3/8-inch NF threads for the "ISE 77" or "Sears Kenmore 700" garbage disposer).
- Make turntable disks from sheet metal (18-gauge (0.048-inch, 1.2 mm) x 5, 5 1/8 and 5 ¼ inch diameter disk for "ISE 77" or "Sears Kenmore 700" garbage disposer, Figure 5).
- Make impeller blades (18 gauge or thicker, 2 3/8 x (4 ½, 4 ¾, 4 7/8 and 5 inch), folded at ¾ inch from the bottom and ¼ inch from the top, Figure 6).
- Bolt the cross-arm on the motor shaft, use thread locker (Loctite 242 Threadlocker or equivalent) to secure the nut.
- Bolt suitable sized turntable disk and impeller blade on the cross-arm.
- Install grinding ring, hopper, hopper retaining ring and rubber splash guard.
- Optional, make rubber faced ring with same dimensions as the original steel grinding ring. Figure 5 shows a rubber faced 'PVC' ring; a rubber strip was attached to the inside of the 'PVC' pipe using spray adhesive such as "3M super 77" spray adhesive.

Variables:

- Grain exit gap, the clearance between the turntable and inside wall of the discharge chamber (Figure 7). The exit gap regulates the duration seeds, kernels and shells stay in the hulling chamber before exiting. With wider gap, seeds have shorter duration in the hulling chamber, lower percent hulled kernels, and fewer cracked and pulverized kernels. Narrow gap allows longer duration in the hulling chamber; higher percent hulled kernels and more cracked and pulverized kernels. For ¼ inch (6.3mm) gap, use a 5 1/8-inch turntable in a 5 5/8 inch inside diameter wall of an "ISE 77" or "Sear Kenmore 700" garbage disposer.
- Hulling gap, the clearance between grinding ring and impeller blade (Figure 8). The ideal hulling gap for sunflower seed approximates the width of the unhulled seed (less than the length and greater than the thickness of unhulled seeds), determined experimentally. For a 5/16-inch (7.9 mm) hulling gap, use a 4 ½ inch impeller blade in a 5 1/8 inch inside-diameter grinding ring on an "ISE 77" or Sears Kenmore 700" garbage disposer.
- Optional, select hulling ring: original steel grinding ring or rubber faced ring.

Figure 1. Kitchen sink garbage disposer, ISE 77, equivalent to Sears Kenmore 700, ¾ horsepower disposer (left) and converted centrifugal impact huller (right).

Figure 2. Disassembled garbage disposer: top row, left to right: insulated jacket and motor. Middle row, sink flange, sink mounting ring and grinding ring.
Bottom row: hopper, hopper retaining ring and rubber splash guard.

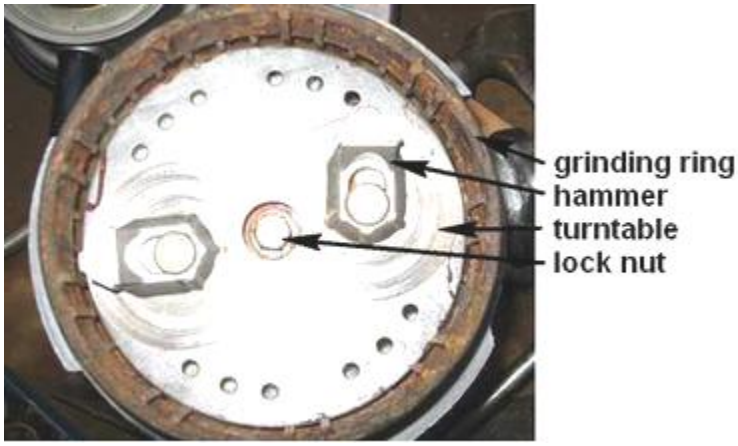

Figure 3. Top view of garbage disposer grinding chamber showing grinding ring, turntable and hammers. Remove the locknut and turntable assembly.

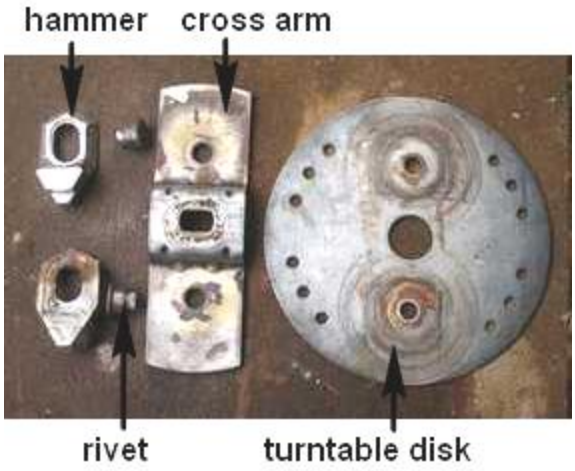

Figure 4. Disassembled turntable. Grind off the rivets to separate cross-arm from hammers and turntable. Tap threads in the rivet holes of the cross-arm.

Figure 5. Components for converting the garbage disposer into grain huller: Top row, left to right, hopper, hopper retaining ring and garbage disposer motor. Middle row, rubber splash guard, rubber faced ring and the steel grinding ring. Bottom row: 3 turntable disks (5, 5 1/8 and 5 ¼ inch diameters) and 2 impeller blades (4 ½ and 4 ¾ inch long).

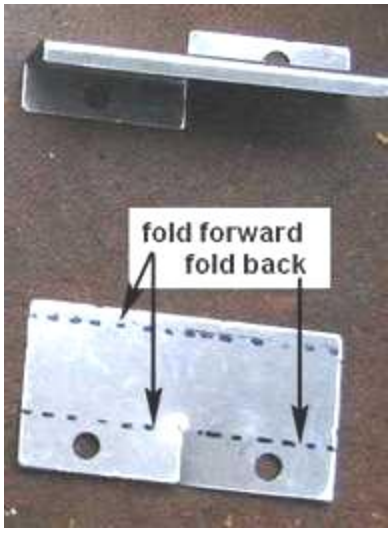

Figure 6. Impeller blade made from sheet metal, 18 gauge (.048 in, 1.2 mm) or thicker.

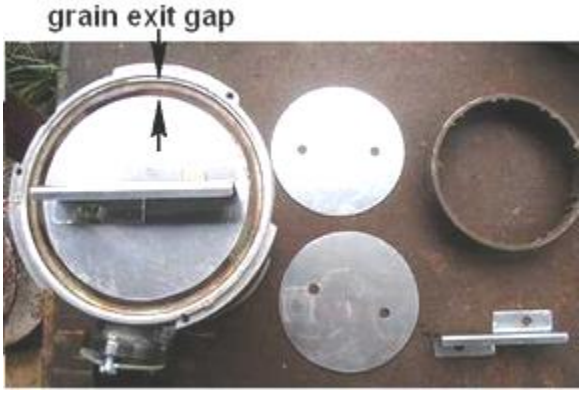

Figure 7. Cross-arm bolted on motor shaft and turntable and impeller blade bolted on cross-arm. The grain exit gap is the distance between turntable and inside wall of the garbage disposer below the grinding ring.

Figure 8. Hulling gap is the distance between impeller blade and grinding ring.

Test procedure:
Confectionery (striped) and oil sunflower (Helianthus annuus) seeds were obtained from a farm store: varieties unknown, moisture content not determined and seed quality for wild birds. Oil sunflower seeds were screened using 8/64 x ¾ inch and 7/64 x ¾ inch slotted screen. One-pound samples of sunflower seeds were hulled. Shells were winnowed out; kernels were separated from unhulled seed using 7/64 x ¾ inch and 6/64 x ¾ inch slotted screens. Feed rate and percent hulled were recorded.

Experimental naked barley (Hordeum vulgare L. var. nudum) was obtained from Professor Hayes at Oregon State University, Corvallis Oregon. The seeds were screened with 7/64 x ¾ inch and 6/64 x ¾ inch slotted screens. Only seeds with hulls were used in the hulling test (seeds that retain their hulls after combine harvesting).

Results:
Confectionery sunflower seeds with large gap between kernel and shell attained a higher percent hulled than smaller oil sunflower seeds (80-90% v 60-76%). Large oil sunflower seeds (>8/64 inch thick) attained a higher percent hulled than smaller seeds (<8/64 and >7/64 inch thick) (76% v 60%). Hulling confectionery sunflower seeds with ribbed steel grinding ring attained a higher percent hulled than with rubber faced ring (80-90% v 40%). Lower feeding rate attained a higher percent hulled confectionery sunflower than higher feeding rate (90% v 80%).

Seed	Huller configuration	Feed rate	Percent hulled
Confectionery sunflower	5/16" (7.9 mm) hulling gap ¼" (6.3mm) exit gap Steel ring	0.45 lb/min =27 lb/h =12.2 kg /h	80%
Confectionery sunflower	5/16" (7.9 mm) hulling gap ¼" (6.3mm) exit gap Steel ring	0.36 lb/min = 22 lb/h =10 kg/h	90%
Confectionery sunflower	5/16" (7.9 mm) hulling gap ¼" (6.3mm) exit gap Rubber faced ring	0.45 lb/min =27 lb/h =12.2 kg /h	40%
Oil sunflower, >8/64 inch thick	3/16" (4.8mm) hulling gap ¼" (6.3mm) exit gap Steel ring	0.29 lb/min = 17 lb/h =7.7 kg/h	76%
Oil sunflower, <8/64 >7/64 inch thick	3/16"(4.8mm) hulling gap ¼" (6.3mm) exit gap Steel ring	0.25 lb/min = 15lb/h =6.8 kg/h	60%
Naked barley, >7/64 inch thick	1/8 (3.2 mm) hulling gap 3/16" (4.8 mm) exit gap Steel ring	0.15 lb/min = 9 lb/h = 4.1 kg/h	93%
Naked barley, <7/64 >6/64 inch thick	1/8" (3.2 mm) hulling gap 3/16" (4.8mm) exit gap Rubber faced ring	0.21 lb/min = 12.9 lb/h = 5.8 kg/h	82%
Naked barley, <7/64 >6/64 inch thick; 2nd seed lot	1/4" (6.4 mm) hulling gap 3/16" (4.8 mm) exit gap Rubber faced ring	0.28 lb/min = 17.1 lb/h = 7.8 kg/h	92%

(Highlight indicates changes)
The garbage disposer centrifugal huller successfully removed hulls from 'naked' barley seeds (82-93%). Barley hulling was less sensitive to hulling gap (1/8 v ¼" inch, 3.2 v 6.4 mm) and easier to hull than sunflower when using rubber faced ring (82-92% v 40%).

Discussion:
Gupta and Das (2) described a high volume experimental sunflower seed huller with rubber-faced ring and achieved the following results on 'Morden' variety of oil sunflower:

- Optimal feeding rate was 100 kg/h, tested in the range of 20 to 200 kg/h. Fraction of hulled kernels decreases with increasing feed rate; but low feeding rates have higher energy consumption per unit of hulled kernels.
- Ideal peripheral speed is 40 m/s; tested in the range of 34 to 54 m/s. Increasing peripheral speed increases the hulling rate and fraction of cracked and pulverized kernels.
- Ideal moisture content is 5-8%, tested in the range of 4-14%. Fraction of hulled kernels decrease with increasing moisture content. Shells with high moisture content flex instead of shatter; very low moisture content resulted in more cracked and pulverized kernels.
- The experimental huller achieved 60 to 93% hulling with an ideal percent hulling at 70-80%. High hulling rates (>80%) resulted in higher fraction of pulverized kernels and higher energy consumption per unit of hulled kernels.

The garbage disposer huller motor speed is 1725 revolutions per minute at no load, for a peripheral speed of 33.8 feet per second (0.86 m/s) on a 4 ½ inch impeller blade and 35.7 ft/s (0.91 m/s) on a 4 ¾ inch impeller blade. A peripheral speed of <1 m/s is not fast enough when using a rubber faced ring for hulling confectionery sunflower seed (40% hulling). However, 1725 rpm is sufficient for hulling confectionery sunflower seeds when using ribbed steel ring and a 5/16-inch (7.9 mm) hulling gap. The discrepancy between hulling with a peripheral speed of <1m/s and 40 m/s may be explained by seed shearing as well as impacting against the ribbed steel wall; no information on wall clearance of the rubber faced huller operated at 40 m/s by Gupta and Das (2). Theoretically, the kinetic energy of impact is proportional to velocity squared (K.E. = ½ mv^2); the difference in kinetic energy between 1 m/s and 40 m/s is 1:1600. Thus, impact hulling at 1 m/s should be 1/1600 of impact hulling at 40 m/s. This suggests shearing is the primary mode of hulling with the garbage disposer huller at <1m/s and suitable hulling gap. Make an assortment of impeller blade lengths for optimizing the hulling gap of the garbage disposer centrifugal huller.

References:
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Technical assistance:
Larry Fisher, Totally Recycled Material, Davis California, www.torema.com.
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Note: Mention of product and company names does not imply endorsement.